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The Failed Thermostat: The Illusion of Control In an Information-Rich Age

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For Guinness,
Faithful companion, Inspired Muse

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Introduction

The concept of command and control is central to modern warfare. Command is a legal and behavioral term referring to a designated individual leader's responsibility and accountability for everything the leader's unit of command does and does not do.[1] Control is a regulatory and scientific term denoting the ability to manage that which is commanded.[2] This paper investigates the use of certain types of control with operating environments that overwhelm commanders' abilities to do their job – lead and succeed in battle. It describes and applies the ideas of a disparate group of sociologists, psychologists, mathematicians, statisticians, and combat leaders to critique the idea of control in contemporary and future military settings and operations. Finally, the paper presents the conclusion that current and future operating environments condemn the idea and language of control to obsolescence. In its place, the paper recommends possible alternative terms that fit and work in those environments.

Command and Control, or C2, particularly dominates discussion in 21st Century warfare because of the importance of information flows within and among units. Those units that have efficient and effective flows, facilitated by good C2, are more successful in operations than those that do not.[3] Such units, also considered to be complex systems, are considered adaptive, thus providing a combat multiplier of flexibility to senior headquarters.[4]

The significant challenge with Command and Control lies with the implications associated with the term, control. By itself, control is innocuous and plainly commonsense; military units, like all complex and simple systems, require regulation to adjudge and adjust performance. Without adequate regulation, systems can suffer from the effects of positive feedback that can quickly lead to system collapse. If a commander does not know what his/her unit is doing or where it is, that commander likely has lost that unit. Unfortunately, the modern battlespace, or in the latest parlance the operating environment, imposes severe complications for control, particularly that form associated with stereotypical military martinets, that is strict or positive control. To adjust to these complications, researchers and practitioners have identified developed several different forms of control. Depending on which research one reads, there are also several taxonomies to describe these forms. This paper will use the four-quadrant taxonomy of control described by Charles Perrow, as presented in his book, Complex Organizations: a Critical Essay.[5] This approach orders control from tight coupling and linear interactions through loose coupling and complex interactions. Coupling refers to the “degree to which actions in one part of the system directly and immediately affect other parts.”[6] Loose coupling in organizations enhances a quality called resilience, or the ability to a system to continue operating after incurring damage to a certain degree; an informal equivalent of this term is called “slack.” Tight coupling in organizations enhances efficiency, saves time, promotes rapid decision making in environments that are

highly predictable.[7] Authority, or control, exists as centralized or decentralized within each quadrant. Perrow believes that military "adventures" or operations fall into the quadrant that has complex interactions and loose coupling; in that case, he suggests that decentralization of authority or control is best.[8] Therein lies the big challenge and problem with control for military operations.

While an expert like Perrow might perceive that decentralization of authority or control is best for systems typified as loosely coupled with complex interactions, others may perceive the challenge presented by battlefields, battlespaces and operating environments as requiring altogether different or centralized authorities and centralized control. Contemporary American military thought holds it axiomatic that planning is centralized while execution is decentralized. Since a military operation involves both planning and execution, it is reasonable to ask, "where does centralization of control stop and decentralized control start?" For example, a historical military master like Frederick the Great of Prussia would consider both planning and execution to be centralized, and he trained his army to excel under these circumstances. Alternatively, another military master, Napoleon Bonaparte, at his peak depended on centralized planning and decentralized execution, including independent initiative perhaps unforeseen by his planning. Finally, the case of Ulysses Grant of the American Army during the American Civil War illustrates the fluidity of a master's thinking about control. When Grant initially took over command – and control – of the Union Armies, he developed through centralized planning a three-pronged

strategy to go on the offensive against the Confederates. That strategy failed in execution. Rebounding from that failure (a unique Grant personal trait), he then decentralized his control, leaving planning and execution to his theater commanders, while he planned and oversaw execution only in the Eastern theater. This approach, coupled with getting the right generals in the right positions, worked and the Union won the war.

These three brief excursions into military history serve to illustrate an apparent phenomenon about decentralized versus centralized authority or control. There seems to be an underlying continuum that enables different forms of control to succeed or fail at different times and places. That continuum can be understood to be the operating environment, battlefield or battlespace in which the operation is planned and executed. Briefly stated, the operating environment is the sine qua non for the choice of type of control.

American Command and Control doctrine appears to recognize the changing and changeable nature of the operating environment and its critical impacts on C2, especially control. The Joint Staff's overarching publication on the matter, Joint Publication 0-2, Unified Action Armed Forces, states that:

> ...**technological advances increase the potential for superiors, once focused solely on the strategic and operational decisionmaking, to assert themselves at the tactical level. While this will be their prerogative, decentralized execution remains a basic C2 tenet of joint operations. The level of control used will depend on the nature of the operation or task, the risk or priority of its success, and the associated comfort level of the commander.**[9]

However, the actual experience of American military forces in actual campaigns seem to belie the decentralized execution aspect of control for highly

centralized planning and control.[10] It appears that <u>all</u> American military operations are of such import, of such a high risk and priority for success, and for the most comfort of senior leaders and commanders as to require very strict control, *as if the operations themselves were tightly coupled, linearly interacting systems.* That these operations in reality are neither tightly coupled nor linearly interacting endangers the very success so desired by all echelons of command. Behaviorally, C2 organizations cannot account for the vagaries of their operating environments.

<u>**Discussion**</u>

Military operating environments are more than just doctrinal slogans included in updated publications. They are real and real in their effects on any efforts to control them. In this section, the paper directly addresses system environments from four perspectives. The first, from classic cybernetics behavioral theory, is Ashby's Law of Requisite Variety. The second is an extended implication from advanced mathematics, Gödel's Incompleteness Theorems. The third is from the statistical control field, Demming's axioms on process control. Fourth and finally, the perspective of modern military thinkers, particularly the late Colonel John Boyd, and the highly correlated thinking of the Department of Defense's C4ISR Cooperative Research Program (CCRP), adds a finishing touch to the discussion. This discussion aims to demonstrate conclusively that (a) systems operating environments are inextricably connected

to systems behavior, and (b) for complex systems, environments can neither be controlled nor accounted for in design.

Ashby's Law

W. Ross Ashby, pioneering cyberneticist and psychologist, attempted to develop underlying general and objective laws of thinking that would facilitate the idea and design for artificial intelligence.[11] His most noted work, Design for a Brain, systematically deduced a series of axioms, theorems, and laws that provided a mechanistic portrait of how the brains works, while still enabling adaptive behavior. His deductive and highly (but not too advanced) mathematical approach provided clear descriptions of system behavior that previously had only been verbally discussed. Ashby's most powerful and original deduction was his Law of Requisite Variety. According to some observers, this Law is the only one from the discipline of Cybernetics, to truly attain scientific law status.[12] Mathematically stated, the Law is:

$$\mathbf{V(E) \geq V(D) - V(R) - K}$$ [13]

Where:

V is a function of variety
E is system or process environment
D is a disturbance to be regulated
R is the regulation
K can be considered friction or entropy

What the law means is that only variety can destroy variety. That is, regulation or control variety must equal or exceed the disturbance variety. Since the disturbance originates in the environment, the regulation or control must be as

robust as the environment, or more precisely, have as much variety or varied behavior as the environment. The Law clearly describes why control systems in anything from home thermostats to aircraft ailerons work. The variety of the controls meets or exceeds that of possible environmental disturbances. The Law also helps one understand why certain control systems do not work as promised. One classic ecological example illustrates this point. Rachel Carson, in her book, Silent Spring, described the insidious and destructive effects of the application of DDT to the physical environment.[14] DDT was a chemical pesticide used to positively control mosquito and other flying insect pest populations. The only variety available to DDT users was the amount and the timing. The relevant population for the users was, naturally, the insect population. However, the pesticide's effects were not limited to the insect population. DDT was and is a persistent and poisonous agent that works its way through food chains, to the top of the chain – that being homo sapiens. Varying amount and timing did not and cannot account for this environmental disturbance. The variety in the physical environment exceeded that of the control agent.

Complex systems environments require matching complex systems controls. Unfortunately for military C2 practitioners, there is an added factor: the inherent dynamic of war's environment. As strategic thinkers from time immemorial have noted, war occurs between two opponents, each of whom constantly adjust and adapt to specific circumstances; Clausewitz aptly described war as a wrestling match in which nothing ever is constant. Not only do control

systems have to match the complexity of the starting or initial operating environment, they also must match the changing patterns and behaviors over time and space. Sometimes decentralization may be appropriate, sometimes not; sometimes a mix of controls may be necessary, sometimes only one. Because of war's dynamic and uncertain nature, one cannot predict, and therefore set controls in advance, what those perturbations necessary to control will be. Control, in the standard C2 concept, is impossible.

Gödel's Incompleteness Theorems

Kurt Gödel was one of the world's foremost mathematicians in the twentieth century. His reputation came from his answer to a mathematical challenge made by David Hilbert, a renowned mathematician in his own right. That challenge, known as Hilbert's Program, was to develop a consistent and finite system of axioms that would completely formalize mathematics, to include proofs that the system was what it purported to be. The impact of such a provable system would be to set up a hierarchy of mathematical types, in which higher forms, like real number analysis, could be proven in terms of simpler forms, the most basic of which is arithmetic. Hilbert was searching for a "system of systems" that would define mathematics completely and consistently.[15] Gödel wrote his most famous article, "On Formally Undecidable Propositions of Principia Mathematica and Related Systems," that demonstrated such a program was extremely unlikely to exist.[16] His argument rested on two theorems that he proved in the article. These are called the Gödel Incompleteness Theorems.

Without going into the extremely advanced mathematical notation and argument that Gödel devised to prove his theorems, one can state the theorems in English:

Theorem 1: *For any consistent formal, computably enumerable theory that proves basic arithmetical truths, an arithmetical statement that is true, but not provable in the theory, can be constructed.*[1] *That is, any effectively generated theory capable of expressing elementary arithmetic cannot be both consistent and complete;*

Theorem 2: *For any formal recursively enumerable (i.e. effectively generated) theory T including basic arithmetical truths and also certain truths about formal provability, T includes a statement of its own consistency if and only if T is inconsistent.*[17]

What these theorems demonstrate is that any but the most trivial mathematical system or theory can be complete or consistent, but not both.

What this paper is interested in is the implication of the two theorems as applied to general systems, not just mathematical logic systems. If general systems are specifications of abstract mathematical systems, then the conclusions associated with the theorems for mathematics can be extended to the more concrete systems that comprise human reality. This is the *assumption* that this paper makes. In this regard, there is a realization that the strict mathematical conditions and limits in which Gödel and Hilbert operated often appear irrelevant to human reality or missing from that reality. In the present case, that irrelevance or missing case merely reflects the incomplete mapping of human reality to mathematical systems and theory.[18]

In a system of systems, the Gödel extension implies that one cannot fully comprehend or understand the system of systems, or if one comprehends that system of systems, the comprehension will prove inconsistent with the reality of the system. Either way, trouble abounds for the concept of control in such a case. One quickly perceives that this trouble closely correlates with the issue of variation addressed by Ashby's Law of Requisite Variety. But, while Ashby's Law seeks to identify the conditions under which regulation or control can take place, Gödel's theorems seem to indicate that at a most basic level, those conditions will prove unworkable or false. Mistakes and accidents not only will, but must, happen no matter how much control system users apply.

Deming's Statistical Control Theory

W. Edwards Deming was a founding father of the American Quality Control movement. An engineer, mathematician, and physicist by education, Deming earned his first note of fame as a U.S. government-sponsored consultant to Japanese industry after the end of World War II. He introduced the concept of statistical quality control to the Japanese, emphasizing the importance of quality built in to products and minimizing the need for inspections after production. He demonstrated that such a business strategy would reduce overall business costs, mainly through eliminating ex post facto fixes to defective products, and would establish enduring supplier-customer relationships that would mitigate uncertainties for both production and consumption. The validity

of Deming's ideas can be found in the facts of the tremendously profitable Japanese "invasion" of multiple products into the United States culminating in the 1980s – Japanese products established themselves as the high quality, high reliability alternative to American products – and in the reverence Japanese industry and government held for Deming, evidenced by the naming of the Japanese quality control award after him.

Reception of Deming's ideas in the United States has been mixed. American industry and government attended his lectures and short courses by the tens of thousands, yet implementation of his "System of Profound Knowledge," considered essential for excellent and continuous quality improvement, was and is spotty. "Quicky" interpretations of Deming, minus the substantive methodology, like Total Quality Management, often have ended up as merely new management fads, like Management By Objectives; they come and they go. Yet, Deming's System of Profound Knowledge remains as valid as it was and is for the Japanese: one can only manage what one knows. He stated this System in four principles:

1. *Appreciation of a system*: understanding the overall processes involving suppliers, producers, and customers (or recipients) of goods and services (*explained below*);
2. *Knowledge of variation*: the range and causes of variation in quality, and use of statistical sampling in measurements;
3. *Theory of knowledge*: the concepts explaining knowledge and the limits of what can be known;
4. *Knowledge of psychology*: concepts of human nature.[19]

Readers may note that this paper has been addressing control in *systems*, as described by Perrow and Ackoff, *variation* of control as described by Ashby's Law, and what the limits are to that which can be *known* (and therefore controlled) from Gödel's Incompleteness Theorems. *Psychology*, or the variation of human control, is addressed in the following section. Deming expounds on his System by stating fourteen (14) principles that would make his System work. All bear on the issue of control in system environments:

1. Create constancy of purpose toward improvement of a product and service with a plan to become competitive and stay in business. Decide to whom top management is responsible.
2. Adopt the new philosophy. We are in a new economic age. We can no longer live with commonly accepted levels of delays, mistakes, defective materials, and defective workmanship.
3. Cease dependence on mass inspection. Require, instead, statistical evidence that quality is built in. (prevent defects instead of detect defects.)
4. End of the practice of awarding business on the basis of price tag. Instead, depend on meaningful measures of quality along with price. Eliminate suppliers that cannot qualify with statistical evidence of quality.
5. Find Problems. It is a management's job to work continually on the system (design, incoming materials, composition of material, maintenance, improvement of machine, training, supervision, retraining)
6. Institute modern methods of training on the job
7. The responsibility of the foreman must be to change from sheer numbers to quality… [which] will automatically improve productivity. Management must prepare to take immediate action on reports from the foremen concerning barriers such as inherent defects, machines not maintained, poor tools, and fuzzy operational definitions.
8. Drive out fear, so that everyone may work effectively for the company.
9. Break down barriers between departments. People in research, design, sales and production must work as a team to foresee problems of production that may be encountered with various materials and specifications.
10. Eliminate numerical goals, posters, slogans for the workforce, asking for new levels of productivity without providing methods.
11. Eliminate work standards that prescribe numerical quotas.

12. Remove barriers that stand between the hourly worker and his right of pride of workmanship.
13. Institute a vigorous program of education and retraining.
14. Create a structure in top management that will push every day on the above 13pts.[20]

When these points and principles are taken together, they bring to the forefront a critical control idea: one must *know* – in a deep epistemological way – what one is measuring (for control) and why it is important to measure it, always ensuring that the measurement is across all elements of the specific process (input, process, output, enablers), not just the process itself.[21]

If one cannot deeply know the system or process, according to Deming, any improvement to the system merely is random. Control is illusory.[22] Can military leaders and forces deeply know their operating environment? All the information technology advances that have been incorporated in the armed forces have that "knowledge awareness" in mind. Yet, the attentive military researcher knows that even with the best of these formidable technologies, the deep knowledge required for control proves illusive. In the dramatic case of Operation ANACONDA, in Afghanistan during 2002, the concentration of all available intelligence, surveillance, and reconnaissance capabilities on a small, fixed geographic area underestimated enemy strength by 100 percent, mis-located the enemy's positions, and failed to identify enemy heavy artillery hiding in plain sight in a village. Only after *human* intelligence directly observed the operational physical environment were the mistakes identified. Even then, the operation executed as planned using the mistaken intelligence as a baseline

rather than adjusting for the corrected intelligence. Obviously and clearly, there was no valid quality control for the operation.[23]

Strategic Thoughts of John Boyd and CCRP

John Boyd was the American intellectual father of maneuver theory[24]; the CCRP community is the birthplace for Network Centric Warfare concepts.[25] The former emphasized the need for focus on the human; the latter continues to promote the possibilities of technological revolution in warfare. Each used and uses different methods to argue their respective cases; Boyd from history and the force of the dialectic, and CCRP from the scientific method. However, both converge ideas on one area: the central role of information in the command and control of military forces.

Boyd's second briefing is titled "Organic Design fro Command and Control." In it he explored the reasons for then recent operational and exercise failures (fiascos is what he called them). He differed from then conventional ideas that the solution to such disasters was to increase the situational awareness of commanders and troops through increased information bandwidth and channels in advocating that an alternative (and by implication, less expensive) solution lay in the "implicit nature of human beings."[26] What Boyd had discovered was that the dual nature of information, that is data plus meaning, required different but strongly related solutions to any problems it presented. Data information problems were amenable to technological

approaches, like increasing bandwidth and channels; problems of what the data meant were impervious to technology and required focus on human behavior. In warfare and military units, these two problem areas converge in the human leadership of units, or command and control. Boyd recognized that the issue of information in command and control was intrinsically part of an environmental problem – of both environments *external* to the unit and also *internal* to it.[27] To have effective command and control, which to Boyd meant having very quick decision cycles while imposing slow ones on the enemy,[28] meant achieving implicit harmony among friendly forces that simultaneously would have the initiative to take advantage of fleeting opportunities and addressing imminent threats. For Boyd, "Command and control must permit one to direct and shape what is to be done as well as permit one to modify that direction and shaping by assessing what is being done…Control must provide assessment of what is being done also in a clear unambiguous way. In this sense, control must not interact nor interfere with systems by must ascertain (not shape) the character/nature of what is being done."[29] Boyd realized that his conception of control was not conventional and sought a substitute phrase that more described what he meant. He first suggested "monitoring," but then settled on "appreciation," because it "includes the recognition of worth or value and the idea of clear perception as well as the ability to monitor. Moreover, next, it is difficult to believe that leadership can even exist without appreciation."[30] Without quibbling over his choice of phrases to describe his desired form of control, one recognizes that

Boyd saw that conventional control, or positive control, was dysfunctional to a fine-tuned decision cycle. In uncertain and dangerous external environments, in which the internal cohesion of an organization is vital to insure protection of the organization's boundaries (think of force protection), implicit command and control guarantees that members of the organization can take appropriate action fast without relying on explicit orders or commands. Boyd's approach would guide an organization along the edge of behavior between chaos and stasis, both of which mean organizational (and in battle, personal) death.

The CCRP research most applicable to the issue of command and control is found in Alberts and Hayes, Power to the Edge: Command... Control... in the Information Age.[31] The authors note that command and control encompasses all four information domains of Network Centric Warfare theory: physical, information, cognitive, and social.[32] This is very close to the levels of combat that Boyd recognized two decades earlier: cognitive, physical and moral. Equally importantly, Alberts and Hayes note that command and control is not about who decides or how the task is accomplished, but about the nature of the tasks themselves. From a work study perspective, this means that organizational members' roles and norms are the key to understanding what makes good or bad command and control.[33] Again, Alberts and Hayes align themselves with Boyd in stressing the human dimension of control. Their research find six prevailing types of successful command and control approaches ranging from very centralized to very decentralized: these six are:

1. Cyclic
2. Interventionist
3. Problem-Solving
4. Problem-Bounding
5. Selective Control
6. Control Free

The factors that determined their effective use are:

> - Warfighting environment–from static (trench warfare) to mobile (maneuver warfare);
> - Continuity of communications across echelon (from cyclic to continuous);
> - Volume and quality of information moving across echelon and function;
> - Professional competence of the decisionmakers (senior officers at all levels of command) and their forces; and
> - Degree of creativity and initiative the decisionmakers in the force, particularly the subordinate commanders, can be expected to exercise.[34]

Generally speaking, static warfighting environments with communications continuity that includes volumes of quality information, or those characterized as more certain or knowable, are conducive to the application of the more centralized command and control approaches, like Cyclic in which orders are routinely published at specific time intervals with great detail. Fluid warfighting environments with discontinuous available communications including questionable information, coupled with a professional force of competent decision-makers who are trained in a creative and innovative professional culture, are amenable to decentralized command and control. In the latter case, control as a integral part of command, becomes as Boyd would put it, “invisible.”

Alberts and Hayes note that today's external military operating environments, with today's armed forces' internal professional environments, strongly tend to the need for decentralized approaches like "control free." As they aptly note, "The Information Age force will require agility in all warfare domains, none more important than the cognitive and social domains. The Strategic Corporal must be recruited, trained, and empowered."[35]

Alberts and Hayes go on to identify the desired characteristics of command and control systems for these likely environments – robustness, resiliency, responsiveness, flexibility, innovation, adaptation – to which one easily could add redundancy (as opposed to duplication.)[36] They then propose their command and control solution, providing power to the edge, where edge refers to the boundaries of an information-age organization, those farthest from the information center. In industrial age organizations, these would be production line workers or the field bureaucrats of some large public sector bureaucracy. Information age organizations that have eliminated the tyranny of distance as a barrier to communications and information, have members at the edge who may be very high ranking; the edge in this instance refers to the edge of idea implementation and formulation.[37] In such organizations, control becomes collaboration.[38] Old fashioned control as regulation, as ensuring meeting pre-ordained criteria, as passing files inspections, as meeting phase-line objectives but not surpassing them, dissolves into obsolescence.

Summary of Discussion

Two major points emerge from the above discussion. The first is the vital and dynamic role of the operating environment in developing command and control approaches. The second is the improbability of control working in current and foreseeable operating environments.

Modern operating environments have the unpredictable habit of reacting to any military force for any use in unpredictable ways. Liberate a country, become condemned as occupiers. Feed the poor, become sucked into intra-gang feuds. Broker a peace, watch the peacekeeping force get butchered.[39] These and others demonstrate to an extent the effects of Jay Forrester's Law of Counterintuitive Behavior of Complex Systems, the unintended consequences of war so well described by Hagan and Bickerton, and by extension the Heisenberg Uncertainty Principle wherein the observer influences the event under investigation.[40] Good intentions lead to bad results. What is more, one cannot ignore the environment; it must be dealt with, but is too complex to control (in the classic sense.) Finally, one cannot leave the operating environment without yielding to defeat. In some cases, defeat may be a least costly option.
As the American Nobel Laureate Physicist, John Archibald Wheeler, has put it, "we live in a participatory universe."[41] One must learn to adjust to the pushback from the complex systems one wishes to adjust.

This last observation directly leads to the second point, that control as traditionally defined and still too often implemented, cannot accomplish what it

sets out to do. The operating environment is too varied (and too varying) for Ashby's Law to enable effective regulation or control. Control, in the Industrial Age conceptualization of managing work efficiency through measurement *always* will fail. Frederick Taylor's Polish shoveler has learned to fight back against the industrial engineer.[42] This author offers a "Z Corollary" to the Law of Requisite Variety: that is, effective regulation only can occur in environments that are predictable and deterministic. If control is to have any meaning or relevance to the new complex, adaptive operating environments of armed forces, it must be radically re-conceived in ways that approach the thinking of Deming, Alberts and Hayes, and Boyd – control that is invisible, passive and harmonizing from the core to the edge.

Conclusions

Command and control is a term that has only been in existence since the height of the Industrial Revolution, around the turn of the 19th Century. The utility of the term has run its course. Operating environments, always influential in wartime, now have become central concern if an armed force is to be successful. These environments are complex, adaptive, uncertain, ambiguous. They do not yield to strong or positive control, nor can they ever since to do so violates natural law as is currently known. Command remains a relevant concept, particularly in rapidly changing, evolving environments, in order to retain some paradoxical semblance of humanity within the environment of war. Once the operating environmental concept extends beyond war, to humanitarian

or peace operations or counterinsurgency, the idea of control in almost any guise becomes a poor joke, often played on those who are closest to the action, the members of the armed forces directly engaged. For the United States, the joke has been played on its armed forces far too many times in recent decades. There has been too much effort by senior leaders, civilian and military, to attempt to make war into their own image rather than realize the war that is. In their efforts to control the image of war, these leaders have deluded themselves and their subordinates. The delusion has proven tragically costly.

One suggestion emerges from this paper. Rather than redefine the idea of control, it is time to dispose of the word, with all its baggage, at least from the military arts. Instead, if one wishes to retain the acronym C2, call the second C "coordination" or "collaboration." Perhaps "monitoring" or Boyd's "appreciation" might work. In eliminating control from the military dictionary, the armed forces free themselves from the self-imposed delusion they have invented. It is better to face the new day and new environment with a fresh and real face.

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[1] For a good summary of command responsibility, see Major Michael L. Smidt, "*Yamashita, Medina* and Beyond: Command Responsibility in Contemporary Military Operations," Military Law Review, Volume 164, pp 155-234, 2000. This instance, see pp. 164-165.

[2] United States Army Field Manual (FM) 6-0, Mission Command: Command and Control of Army Forces, Washington: Headquarters, Department of the Army, 2003. Chapter 3, page 3-1.

[3] Joseph Olmstead, Battle Staff Integration, Alexandria, Virginia: Institute for Defense Analyses Paper P-2560, February, 1992. Chapter V.

[4] United States Marine Corps Doctrine Publication 6, Command and Control, Washington: Headquarters, United States Marine Corps, 4 October 1994. See pages 44-47.

[5] Third Edition, New York: McGraw-Hill. 1986. See pages 149-150.

[6] Karl Weick and Kathleen Sutcliffe, Managing the Unexpected, San Francisco: Jossey-Bass, 2007. Page 91.
[7] Perrow, page 148.
[8] Ibid, page 150.
[9] Joint Publication 0-2, Unified Action Armed Forces; Washington: Joint Chiefs of Staff, 10 July 2001. Page III-13.
[10] The intrusion of senior civilian and military leadership into the actual and detailed planning and execution of military operations long has been observed within the American military experience. Vietnam has been the most recorded case; for example read H.R. McMaster, Dereliction of Duty: Johnson, McNamara, the Joint Chiefs, and the Lies that led to Vietnam; New York: Harper Perennial, 1998. Many readers may argue that Operation IRAQI FREEDOM may place a close second to Vietnam. For example, read Michael Gordon and Bernard Trainor, COBRA II: the Inside Story of the Invasion and Occupation of Iraq; New York: Vintage, 2008; and Thomas Ricks, Fiasco: The American Military Adventure in Iraq; New York: Penguin, 2007. Those are only two illustrations of many cases that stretch back into the 19th Century. For a classic look at the phenomenon, read Russell Weigley, The American Way of War: A History of United States Strategy and Military Policy; Bloomington, Indiana: Indiana University Press, 1977. Finally, for a very recent report on an old war, the Korean Conflict, that illustrates the great danger of misapplying command and control, read the late David Halberstam's, The Coldest Winter: America and the Korean War; New York: Hyperion Books, 2008.
[11] W. Ross Ashby, Design for a Brain; New York: John Wiley & Sons, 1960. Pages v-vi.
[12] See website of Principia Cybernetica, http://pespmc1.vub.ac.be/REQVAR.html, accessed March 8, 2008.
[13] Ibid. Also, see Ashby, page 229.
[14] Rachel Carson, Silent Spring; Boston: Houghton-Mifflin, 1962.
[15] Found at the Stanford University Library of Philosophy website, http://plato.stanford.edu/entries/hilbert-program/, accessed March 8, 2008.
[16] The article appeared in a German periodical, Monatshefte fur Mathematik und Physik, Volume 38 (1931), pp. 173-198.
[17] http://en.wikipedia.org/wiki/G%C3%B6del%27s_incompleteness_theorem, accessed March 8, 2008. Since Wikipedia is a questionable source for such matters, albeit a highly useful and convenient one, also check Ernest Nagel and James R. Newman, Gödel's Proof; New York: New York University Press, 1986, pp. 58-59 for different wording that is equivalent to the Wikipedia statements, but much longer.
[18] Note that this is a controversial assumption and argument. There is a significant school of thought that makes the case that one cannot reasonably extend Gödel beyond the boundaries of axiomatic thinking. Read, for example, http://www.cscs.umich.edu/~crshalizi/notabene/godels-theorem.html, accessed 9 March 2008.
[19] W. Edwards Deming, Out of the Crisis; Cambridge, Massachusetts: Massachusetts Institute of Technology Center for Advanced Engineering Study, 1986. Chapter 1.

[20] Ibid, Chapter 2. Note that the 14th point has undergone revision since first espoused. Here the current statement is used; in Deming's book, the statement reads, "Put everyone in the company to work to accomplish the transformation. The transformation is everybody's job." Page 24.
[21] Ibid, Chapter 11. In this chapter, Deming provides several methodological ways to know what one is measuring, as well as several misuses of the same methodologies.

[22] For those of us who attended Deming classes, the "red-white bead" experiment is a classic illustration of not knowing a process, yet demanding improvement. A version of this experiment is described in Chapter 11, ibid.
[23] An excellent account of Operation ANACONDA can be found in Sean Naylor, Not A Good Day To Die: The Untold Story of Operation ANACONDA; Berkeley, California: Berkley Books, 2006.
[24] For such a tremendous influence on modern strategic theory, John Boyd has very little written and published. His magnum opus was a collection of four extended briefings with notes, the conduct of which took upwards of fourteen (14) hours to complete. Those collected briefings, titled A Discourse on Winning and Losing, constitute the vast majority of Boyd's strategic ideas. The version used here is from August, 1987, reproduced by John Boyd for the author in 1990.
[25] The C4ISR Cooperativel Research Program, following its name and mission from the Department of Defense, has published numerous books and articles. The source CCRP document on Network Centric Warfare is David S. Alberts, John J. Garstka, and Frederick P. Stein, Network Centric Warfare: Developing and Leveraging Information Superiority, 2nd Edition (revised); Washington: DoD CCRP, August, 1999. It is to the credit of this organization that most of their publications are available to the public, at no charge, via their website, www.dodccrp.org.
[26] Boyd, "Organic Design for Command and Control," in Discourse on Winning and Losing, unpublished, May, 1987, page 3.
[27] Ibid., page 20.
[28] Boyd's Decision Cycle or Loop, the Observation-Orientation-Decision-Act or OODA Loop, has become quite the standard by which one can adjudge military efficiency and effectiveness. It is found originally formulated in his first briefing, "Patterns of Conflict," within the same Discourse set, page 131. One of the major drawbacks of applying OODA Cycles to organizations is that the Cycle reflects an individual cycle, not an organization's cycle. Be that as it may, the are other theoretical models, all empirically found valid and reliable, that can be used for organizations. For example, Schein's Adaptive-Coping Cycle, found in Edgar Schein, Organizational Culture and Leadership; San Francisco: Jossey-Bass, 1991.
[29] "Organic Design....," page 31.
[30] Ibid., page 32.
[31] David S. Alberts and Richard E. Hayes, Power to the Edge: Command... Control... In the Information Age; Washington: Department of Defense C4ISR Cooperative Research Program, 2005.
[32] Ibid., page 14.
[33] Ibid, page 17. Also to study how work should be organized, consider Elliott Jaques, Requisite Organization; Green Cove Springs, Florida: Cason Hall & Company, 1989.
[34] Power to the Edge... pp. 19-20.
[35] Ibid. page 69.
[36] Ibid., page 126.
[37] Ibid., pp. 176-177.
[38] Ibid., this is a summary of Chapter 11 as applied to control.
[39] The three examples of counterintuitive behavior are Iraq, 2003 in the first case; Somalia, 1992-3 in the second; and Rwanda, 1994 in the third case.
[40] Forrester's Law is found in a classic systems theory article, Jay W. Forrester, "Counterintuitive Behavior of Social Systems", *Technology Review*, Vol. 73, No. 3, Jan. 1971, pp. 52-68. Kenneth Hagan and Ian Bickerton's extraordinary exploration into the effects of war is found in their, Unintended Consequences: The United States at War; London: Reaktion Books, 2007. Heisenberg's Uncertainty Principle and

extensions can be found at the American Institute of Physics website, http://www.aip.org/history/heisenberg/p08.htm, accessed March 9, 2008.

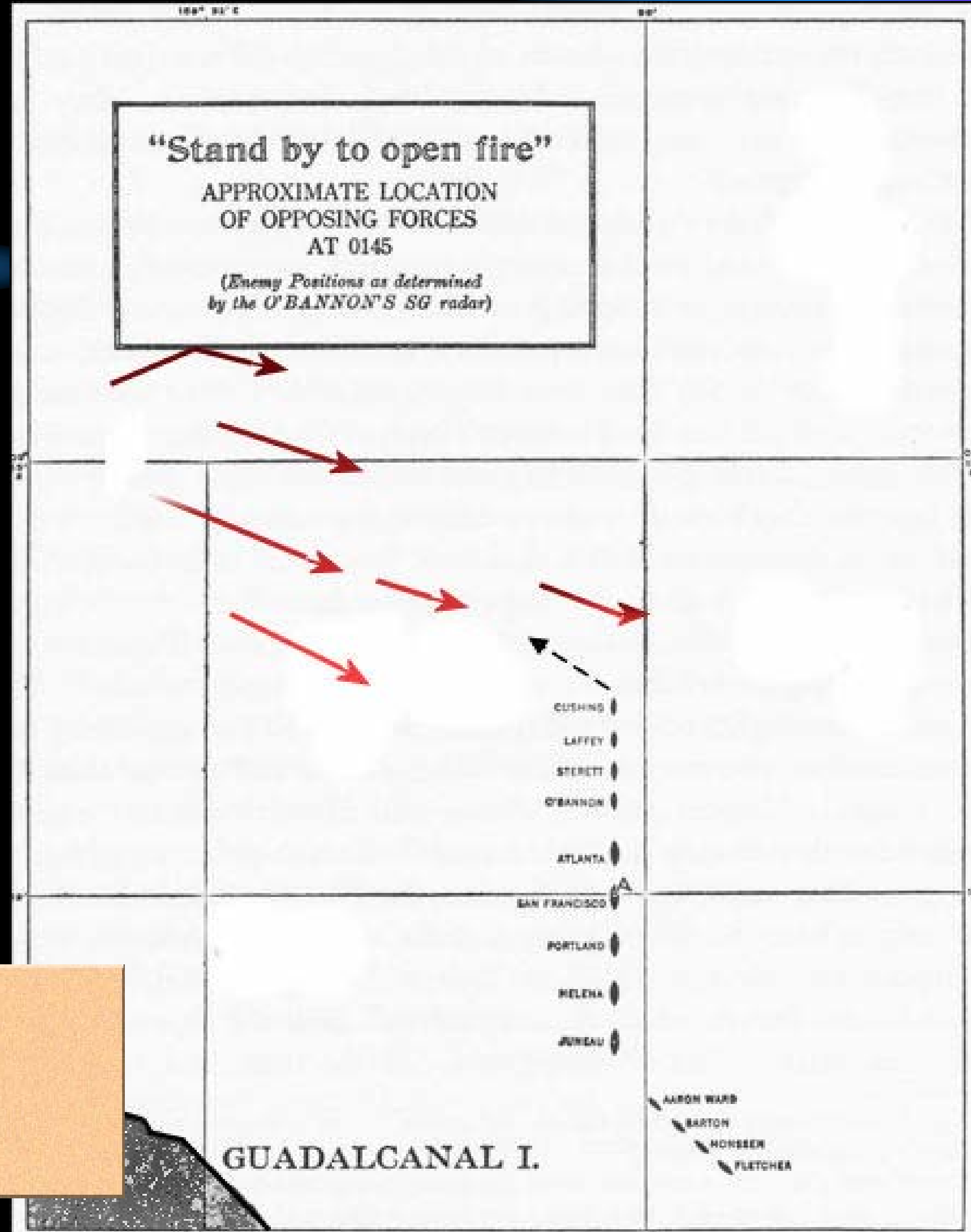
[41] John Archibald Wheeler, "Information, Physics, Quantum: The Search for Links," In Wojciech H. Zurek (editor), Complexity, Entropy, and the Physics of Information; Boulder, Colorado: Westview Press, 1990. Pages 3-28. The phrase, participatory universe, appears on page 5.

[42] The reference is to the classic industrial age management tome, Frederick Taylor's, The Principles of Scientific Management; New York: W.W. Norton & Company, 1967. Taylor developed his ideas observing Polish steelworkers shoveling coal at a plant.

The Failed Thermostat: The Dangerous Illusion of Control of the Battlespace

A Parable on Command And Control: 13 November 1942

WAR INSTRUCTIONS
UNITED STATES NAVY
1944



The Objective

1. Present a compelling argument to abandon the concept of “Control” from C2 related doctrine.

2. Provide an alternative concept that replaces “Control” with a more descriptive and useful term.

Method

1. Reasoned argument and logic from the existing and relevant body of theory and evidence.

2. Case studies illustrating the validity of the argument and logic.

Definitions: Ashby’ s Law of Requisite Variety

$$V(E) \geq V(D) - V(R) - K$$

Where:

V is a function of variety

E is system or process environment

D is a disturbance to be regulated

R is the regulation

K can be considered friction or entropy

Definitions: Gödel's theorems of Incompleteness

Theorem 1: *For any consistent formal, computably enumerable theory that proves basic arithmetical truths, an arithmetical statement that is true, but not provable in the theory, can be constructed. That is, any effectively generated theory capable of expressing elementary arithmetic cannot be both consistent and complete.*

Theorem 2: *For any formal recursively enumerable (i.e. effectively generated) theory T including basic arithmetical truths and also certain truths about formal provability, T includes a statement of its own consistency if and only if T is inconsistent.*

Definitions: Deming's Principles of Statistical Control

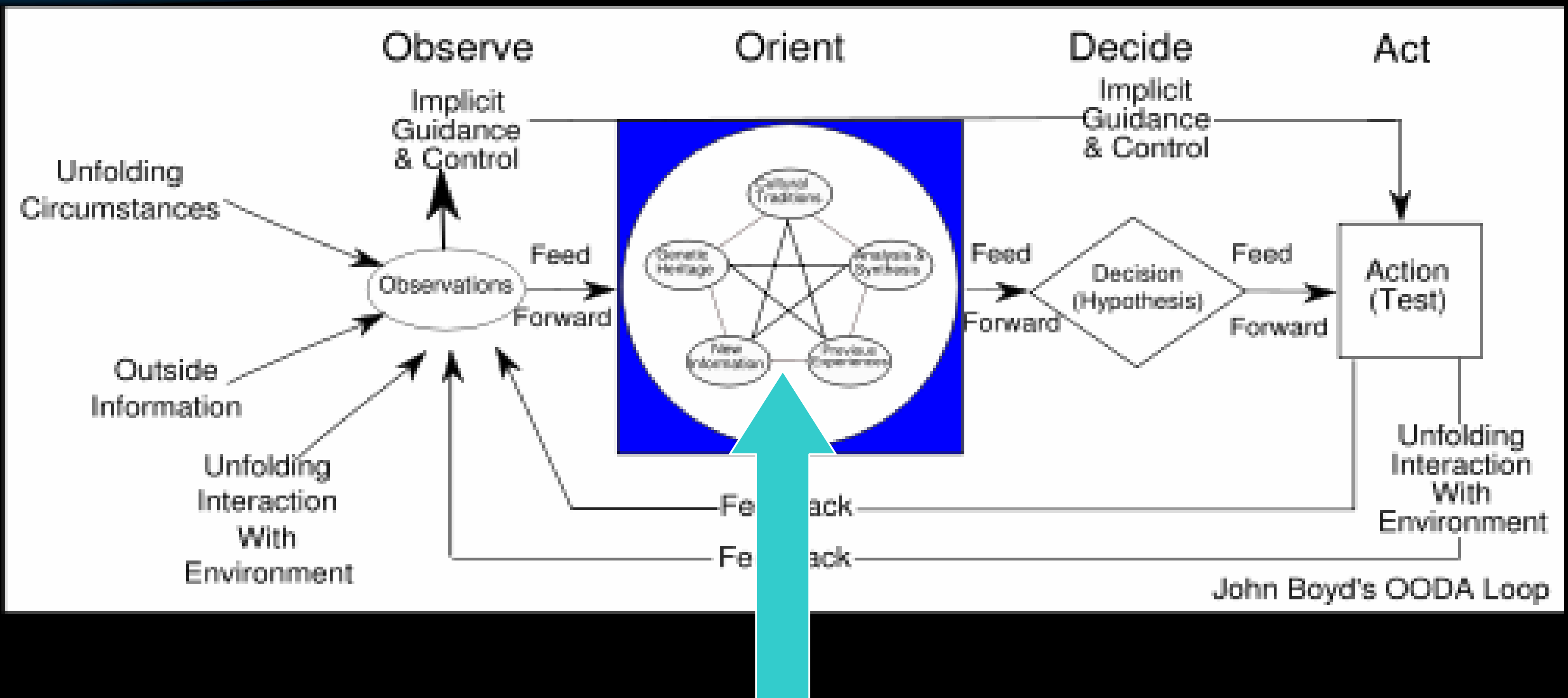
1. *Appreciation of a system*: understanding the overall processes involving suppliers, producers, and customers (or recipients) of goods and services (*explained below*);

2. Knowledge of variation: the range and causes of variation in quality, and use of statistical sampling in measurements;

3. Theory of knowledge: the concepts explaining knowledge and the limits of what can be known;

4. Knowledge of psychology: concepts of human nature.

Definitions: Boyd's Command and Control Theory



The Big "O"

-Leadership

- Appreciation

Definitions: CCRP Concepts of Command & Control

Command and Control Approaches

1. Cyclic
2. Interventionist
3. Problem-Solving
4. Problem-Bounding
5. Selective Control
6. Control Free

Factors:

1. Warfighting environment
2. Continuity of communications across echelon
3. Volume and quality of information moving across echelon and function;
4. Professional competence of the decision-makers and their forces;
5. Degree of creativity and initiative the decision-makers in the force, particularly the subordinate commanders, can be expected to exercise.

Argument and Logic

1. All definitions agree: control of complex system environments is impossible.

2. This leaves two choices:

   a. Reduce the complex environment to simplicity (and control-ability)
   b. Or, abandon the attempt to control

Evidence: Examples

1. Callaghan at Guadalcanal
2. McClellan at Antietem
3. Prussians at Jena and Auerstadt
4. ROLLING THUNDER
5. ANACONDA
6. Russians at Grozny 1994
7. BARBOROSSA

Observations

1. There are two ways of dealing with “control”

   a. Technology - Data
   b. Training – Meaning

2. Quantity of Information (Q(H)) approaches infinity

   a. Q(H) complicates environment
   b. Q(H) decreases time to Information Overload

3. Speed accelerates (2) above

4. What is left to control?

Recommendations

1. Control is Newtonian in its implications and effects.

2. We live in an increasingly Quantum world.

3. It is time to leave “control” behind.

4. Replace with whatever suits/fits the circumstances, e.g.

   a. Collaboration
   b. Coordination
   c. Monitoring
   d. Appreciation